UNIT: Measurement

Broken Arm Blueprint

OBJECTIVE:

Use **precision measurement** tools to measure and compare the physical properties of “replacement parts.”

GOAL:

You're acting as a biomedical engineer helping to design a replacement rod for a broken arm. Your job is to measure and test different sample materials and decide which one is the best match for the “reference bone.”

Materials:

* Calipers or ruler (for measuring diameter/thickness)
* Samples of rod-like materials (pencil, plastic straw, paper straw, wooden dowel, etc.)
* Digital scale or balance (for weight comparison)
* Optional: Spring + weights (to test compression)
* “Reference part” (plastic bone or wooden dowel marked as the ideal)
* Data recording sheet

STUDENT DIRECTIONS:

1. **Measure Size**

* Use the **calipers or ruler** to measure the **diameter and length** of each sample rod.
* Compare those measurements to the reference part.
* Record all your data in a chart.

**Data Example Table:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **Diameter (mm)** | **Length (cm)** | **Matches Reference? (Yes/No)** |
| Pencil |  |  |  |
| Dowel |  |  |  |

1. **Compare Strength (Qualitative Test)**

* Pick up each sample and gently press it down over a table edge to **feel stiffness** (Does it bend? How much?).
* Optional: Stack small weights on top or use a spring compression setup to test how much each sample resists force.
* Observe and record which ones **stay straight, bend, or collapse**.

1. **Check Weight or Density**

* Use a **digital scale** to find the mass of each sample.
* Consider how the **weight might affect comfort and usability** if it were inside a human arm.

**Density Tip:** A heavier but smaller part may be **denser**, meaning its material is more compact and possibly stronger.

1. **Choose the Best Match**

* Based on your data, pick the material that is **closest in size, strength, and weight** to the reference part.

**Discussion Prompt:**

* How does the bulk structure (the way the material is built or packed) affect its strength and function?
  + Think about bones—are they solid or hollow? Why?

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* + Why might we not always want the heaviest or hardest material?  
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* How does the bulk structure of a material relate to its strength or function?

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Standards Alignment

NGSS: HS-PS1-3 STEL: STEL 1E, STEL 2E, STEL 3E, STEL 4E, STEL 5E CCSS: CCSS.MATH.CONTENT.HSN-Q.A.1, CCSS.MATH.CONTENT.HSN-Q.A.2, CCSS.MATH.CONTENT.HSN-Q.A.3, CCSS.MATH.CONTENT.6.SP.B.4–5, CCSS.MATH.PRACTICE.MP4, CCSS.MATH.PRACTICE.MP5